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OBLON, SPIVAK, MCCLELLAND MAIER & NEUSTADT, L.L.P. 1940 DUKE STREET ALEXANDRIA, VA 22314			EXAMINER JACOB, OOMMEN	
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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### Office Action Summary

**Application No.**

10/581,037

**Applicant(s)**

TOMITA ET AL.

**Examiner**

OOMMEN JACOB

**Art Unit**

2613

**Period for Reply** -- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 29 January 2010.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1,3-11 and 13-20 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1,3-11 and 13-20 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 30 May 2006 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO/SB/08)
- 4) ☐ Interview Summary (PTO-413)
- 5) ☐ Paper No(s)/Mail Date \_\_\_\_\_
- 6) ☐ Other: \_\_\_\_\_

## **DETAILED ACTION**

### ***Response to Arguments***

Applicant's arguments with respect to Claims 1, 3-11 and 13-20 have been considered but are moot in view of the new ground(s) of rejection.

### ***Drawings***

1. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the Claims. Therefore, the features of Claims 3-5, and 13-15 must be shown or the feature(s) canceled from the claim(s). Claims 3-5, and 13-15, correspond to a second station as described in applicant specification pages 20-21. For example, the limitations "a single phase modulator for first phase modulation means and the second modulation means" (in Claims 3, 13), "rotated by 90 degrees after the phase difference is produced there between" (in Claim 4, 14), and "phase difference corresponding to the value of random number bit and 180 degree phase difference between the orthogonally polarized components are produced at the same time" (in Claim 5, 15), as described in Applicant specification Page 20-21 needs to be shown in the drawings, because Figures 3 and 5, provided by applicant, corresponding to the second station does not explicitly show them. No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended

replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

### ***Claim Objections***

2. Claims 3 and 13 objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Applicant's argument, page 10 lines 22 to page 11 line 3, states that the means for producing phase according to random number bits and means for producing 180 degree phase shift are "distinct elements that perform different functions". Hence distinct elements that perform different functions are needed to provide the two phase modulations.

3. Claims 4-8 and 14-18 are objected to because of the following informalities:

Claims 4 and 14 recites the limitation "the phase difference" in line 4. It is not clear if the limitation refers to phase difference corresponding to value of random number, or phase difference of 180 degrees. Examiner interprets the limitation as "phase difference corresponding to value of random number". Appropriate correction is required.

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. **Claims 1 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishioka ["Circular Type Quantum Key distribution", IEEE Photonics Technology Letters, VOL.14, No4, April 2002] in view of Hidehiko [JP 05-241104].**

As per Claim1

Nishioka discloses a communication system comprising:

a transmission path for serving as a transmission medium of light (Nishioka Fig 3 item 'communication fiber channel');

a first station having means for emitting time-divided optical pulses divided by a first- time-dividing means into the transmission path (Nishioka ¶0006 discloses splitting

of pulse at coupler to be sent to the second station 'Alice'. One pulse has delay line in the forward direction such that they reach 'Alice' at different times) and for measuring a phase difference between the optical pulses returning from the transmission path (Nishioka Fig 3 and ¶0006 lines 23-25 disclose that first station Bob has two photo detectors that detect pulses according to the phase difference between them. Measurement of photons received, provides a measure of phase. This is the phase measuring means claimed by applicant in Fig 2 and specification page 34 line 12-19 ); and

a second station which reverses traveling directions of the optical pulses (Nishioka Fig 3 station Alice sends back the time divided pulses to station 'Bob' after polarization control and phase modulation), the second station including:

first phase modulation means (Nishioka Fig 3 item PMA is phase modulator) for producing the phase difference, corresponding to a value of a random number bit to be transmitted, between the time- divided optical pulses divided by the first-time dividing means (Nishioka ¶0002 discloses phase modulating photons with quantum key information. Quantum key is a random string of bits shared by communicating devices for security purposes. In Nishioka, the information of quantum key is phase encoded on the two, time delayed pulses),

a second means for splitting each entering optical pulse into orthogonally polarized components (Nishioka Fig 3 item PBS in 'Alice' is a polarization beam splitter that splits a pulse into orthogonal components);

means for rotating each polarization direction (Nishioka Fig 3 item PCA is polarization controller for controlling polarization rotations of the pulses), and

means for combining the orthogonally polarized components and for reemitting the optical pulses into the transmission path (Nishioka Fig 3 item PBS in 'Alice' recombines pulses traveling in opposite directions).

The difference between the instant Claim and Nishioka is that Nishioka does not expressly teach a second modulation means for providing an additional 180 phase difference between the orthogonal components and that the polarization rotation means rotates each polarization each orthogonal components by 90 degrees.

Hidehiko teaches a method of producing 90 degree rotation for orthogonal components traveling in opposite directions (Hidehiko drawing 5b and ¶0012. A 90 degree rotation in the polarization domain causes a 180 degree shift in the phase domain. Hence this Faraday rotator can be used to control polarization rotations as well as produce additional phase shifts).

At the time of invention it would have been obvious to a person of ordinary skill in the art to use a polarization rotation device, such as in Hidehiko, in the second station 'Alice' of Nishioka, as polarization controller device. The motivation for the combination would have been to provide phase encoding schemes for the quantum distribution key data, using additional phase differences, corresponding to the polarization rotations caused by the polarization controllers.

As per Claim 11

Nishioka teaches a communication method comprising:

emitting, at a first station time-divided optical pulses divided by a first time-dividing means into a transmission path (Nishioka ¶0006 discloses splitting of pulse at coupler to be sent to the second station 'Alice'. One pulse has delay line in the forward direction such that they reach 'Alice' at different times) and measuring a phase difference between the optical pulses returning from the transmission path (Nishioka Fig 3 and ¶0006 lines 23-25 disclose that first station Bob has two photo detectors that detect pulses according to the phase difference between them. Measurement of photons received, provides a measure of phase. This is the phase measuring means claimed by applicant in Fig 2 and specification page 34 line 12-19); and

reversing, at a second station having the transmission path, a traveling direction of the optical pulses (Nishioka Fig 3 station Alice sends back the time divided pulses to station 'Bob' after polarization control and phase modulation),

splitting, by second time-dividing means, the optical pulses divided by the first time-dividing means into orthogonally polarized components (Nishioka Fig 3 item PBS in 'Alice' is a polarization beam splitter that splits a pulse into orthogonal components), producing, by first phase modulation means the phase difference, corresponding to a value of a random number bit to be transmitted, between the optical pulses divided by the first time-dividing means (Nishioka Fig 3 item PMA is phase modulator. Nishioka ¶0002 discloses phase modulating photons with quantum key information. Quantum key is a random string of bits shared by communicating devices for security purposes. In Nishioka, the information of quantum key is phase encoded on the two, time delayed pulses),



rotating, by means for rotating polarization direction of each polarized component (Nishioka Fig 3 item PCA for rotating polarizations)

combining, by means for combining, orthogonally polarized components of each optical pulse, and reemitting the optical pulses into the transmission path (Nishioka Fig 3 item PBS in 'Alice' recombines pulses traveling in opposite directions).

The difference between the instant Claim and Nishioka is that Nishioka does not expressly teach a second modulation means for providing an additional 180 phase difference between the orthogonal components and that the polarization rotation means rotates each polarization each orthogonal components by 90 degrees.

Hidehiko teaches a method of producing 90 degree rotation for orthogonal components traveling in opposite directions (Hidehiko drawing 5b and ¶0012. A 90 degree rotation in the polarization domain causes a 180 degree shift in the phase domain. Hence this Faraday rotator can be used to control polarization rotations as well as produce additional phase shifts).

At the time of invention it would have been obvious to a person of ordinary skill in the art to use a polarization rotation device, such as in Hidehiko, in the second station 'Alice' of Nishioka, as polarization controller device. The motivation for the combination would have been to provide phase encoding schemes for the quantum distribution key data, using additional phase differences, corresponding to the polarization rotations caused by the polarization controllers.

**5. Claims 4, 6-8, 14 and 16-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishioka ["Circular Type Quantum Key distribution", IEEE Photonics Technology Letters, VOL.14, No4, April 2002] in view of Hidehiko [JP 05-241104], and further in view of Negami [US PAT NO: 5471545].**

As per Claim 4

Nishioka in view of Hidehiko further teaches a communication system, wherein after each entering optical pulse is split into orthogonally polarized components (Nishioka Fig 3 item PBS is polarization beam splitter), the split polarized components are input to different terminals of a phase modulator (Nishioka Fig 3 shows orthogonally polarized light entering PMA from two different terminals), and the polarization directions thereof are rotated by 90 degrees (Hidehiko drawing 5b and ¶0012 shows 90 degree polarization rotator), and then the split polarized components are recombined (Nishioka Fig 3 returning pulses are recombined at PBS and sent back to station 'Bob') .

Nishioka in view of Hidehiko does not expressly disclose rotating the polarization directions after the phase difference is produced there between.

Negami teaches rotating the polarization directions after the phase difference is produced there between (Negami Fig 1 shows polarization modulating section after the phase changing section).

At the time of invention it would have been obvious to a person of ordinary skill in the art to modify the phase modulation and encryption method disclosed in Nishioka in view of Hidehiko, by integrating the method of phase modulation and polarization control as taught by Negami.

The motivation for the combination would be to effectively modulate light without requiring a process of regulating state of polarization of light incident (Negami Col 2 lines 45-48).

As per Claim 6

Nishioka in view of Hidehiko and Negami further teaches wherein after each entering optical pulses is split into the orthogonally polarized components, optical paths along which the split polarized components propagate before entering the different terminals of the phase modulator are composed of a polarization-maintaining optical fiber (Negami Col 4 lines 45-50 disclose use of polarization maintaining fiber).

As per Claim 7

Nishioka in view of Hidehiko and Negami further teaches wherein by orienting a polarizing axis of the polarization-maintaining optical fiber along electric-field vectors of the orthogonally polarized components of the entering optical pulse (Negami Col 5 lines 35-40 discloses axis of polarization of incident light parallel (in orientation) with stress applied to path. Col 6 lines 35-38 discloses piezoelectric to apply stress. Hence orientation of axis of polarization will be parallel to electric field caused by the piezoelectric), the split polarized components are combined with their polarization directions rotated by 90 degrees (Nishioka Fig 3 the components are combined at PBS in 'Alice').

As per Claim 8

Nishioka in view of Hidehiko and Negami further teaches wherein a Faraday rotator is used as the means for producing the 180-degree phase difference between

the orthogonally polarized components and the means for rotating each polarization direction by 90 degrees (Hidehiko drawing 5b and ¶0012 shows 90 degree Faraday rotator).

As per Claims 14 and 16-18

Claims 14 and 16-18 are drawn to the method used by the corresponding apparatus Claims 4 and 16-18, and are rejected for the same reasons of obviousness used above.

**6. Claims 5 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishioka ["Circular Type Quantum Key distribution", IEEE Photonics Technology Letters, VOL.14, No4, April 2002] in view of Hidehiko [JP 05-241104], and further in view of Negami [US PAT NO: 5471545], and further in view of Bethune [US PAT NO: 6188768].**

As per Claim 5

Nishioka in view of Hidehiko and Negami does not expressly teach wherein after each entering optical pulses is split into the orthogonally polarized components, distances along which the split polarized components propagate before entering the phase modulator are set to be different for each polarized component, and by temporally varying driving voltage, the phase difference corresponding to the value of the random number bit and the 180-degree phase difference between the orthogonally polarized components are produced at the same time

Bethune teaches after each entering optical pulses is split into the orthogonally polarized components (Bethune Fig 5A and Col 8 lines 55-57), distances along which the split polarized components propagate before entering the phase modulator are set to be different for each polarized component (Bethune Col 8 line 65-Col 9 line 8 discloses the advantages of setting distances traveled to the phase modulator same. This implies the method of setting different distances were considered, and have different time and phase variations for both components), and by temporally varying driving voltage (Bethune Col 2 lines 60-67 discloses proton exchange phase modulators, that inherently require drive voltages applied to electrodes for phase modulation), the phase difference corresponding to the value of the random number bit and the 180-degree phase difference between the orthogonally polarized components are produced) at the same time (Bethune Col 7 lines 32-46 discloses selection of basis for modulation and the coding of the bits inside PM2. A total phase shift for pulse takes place inside PM2).

At the time of invention it would have been obvious to a person of ordinary skill in the art to modify the phase modulator disclosed in Nishioka by integrating phase coding scheme as taught in Bethune to provide a method of QKD protocol in the apparatus in Nishioka.

As per Claim 15

Claims 15 is drawn to the method used by the corresponding apparatus Claim 5 and is rejected for the same reasons of obviousness used above.

**7. Claims 9 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishioka ["Circular Type Quantum Key distribution", IEEE Photonics Technology Letters, VOL.14, No4, April 2002] in view of Hidehiko [JP 05-241104], and further in view of Sedylmayr [US PAT NO: 6188768].**

As per Claim 9

Nishioka in view of Hidehiko further teaches wherein a polarization beam splitter is used as the means for splitting each of the optical pulses into the orthogonal components and the means for combining the orthogonal components (Nishioka Fig 3 the components are combined at PBS in 'Alice'),

Nishioka in view of Hidehiko does not expressly teach an antireflection termination provided at a port, from which a polarized component resulting from a deviation from the polarization rotation angle of 90 degrees is output, of the polarization beam splitter.

Sedlmayr teaches an antireflection termination is provided at a port (Sedlmayr ¶0274 lines 8-10 discloses transmission of one component only), from which a polarized component resulting from a deviation from the polarization rotation angle of 90 degrees is output, of the polarization beam splitter (Sedlmayr ¶0297 and Fig 8A, discloses deflection of one polarization by a polarizing analyzer).

At the time of invention it would have been obvious to a person of ordinary skill in the art to modify the phase modulation and encryption method disclosed in Nishioka in view of Hidehiko, by integrating the method of beam splitting disclosed by Sedlmayr.

The motivation would have been to provide a polarizing beam splitter that is less costly to produce and weigh less than a cube polarizer (Sedlmayr ¶0274 lines 19-22).

As per Claim 19

Claims 19 is drawn to the method used by the corresponding apparatus Claim 9 and is rejected for the same reasons of obviousness used above.

**8. Claims 3, 10, 13 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishioka ["Circular Type Quantum Key distribution", IEEE Photonics Technology Letters, VOL.14, No4, April 2002] in view of Hidehiko [JP 05-241104], and further in view of Bethune [US PAT NO: 6188768].**

As per Claim 3

Nishioka in view of Hidehiko does not expressly teach wherein a single phase modulator is used for the first phase modulation means and the second phase modulation means.

Bethune teaches wherein a single phase modulator is used for the first phase modulation means and the second phase modulation means (Bethune Col 7 line 33-65 discloses phase coding schemes to provide a phase depending on the random number bit as well as to select a basis for providing phase shift).

At the time of invention it would have been obvious to a person of ordinary skill in the art to modify the phase modulator disclosed in Nishioka by integrating phase coding scheme as taught in Bethune to provide a method of QKD protocol in the apparatus in Nishioka.

As per Claim 10

Nishioka in view of Hidehiko further teaches a quantum cryptographic key is distributed (Nishioka ¶0002).

Nishioka in view of Hidehiko does not expressly teach wherein the second station has means for attenuating intensity of each optical pulse to include no more than 1 photon per bit when reemitting the optical pulses into the transmission path after combining the orthogonally polarized components.

Bethune teaches wherein the second station has means for attenuating intensity of each optical pulse to include no more than 1 photon per bit when reemitting the optical pulses into the transmission path after combining the orthogonally polarized components (Bethune Col 5 lines 60-66 discloses attenuator for single photon pulse to be returned).

At the time of invention it would have been obvious to a person of ordinary skill in the art to modify the phase modulator disclosed in Nishioka by integrating phase coding scheme as taught in Bethune to provide a method of QKD protocol in the apparatus in Nishioka.

As per Claim 13 and 20

Claims 13 and 20 are drawn to the method used by the corresponding apparatus Claim 3 and 10 and are rejected for the same reasons of obviousness used above.



***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to **OOMMEN JACOB** whose telephone number is (571) 270-5166. The examiner can normally be reached on Monday – Friday, 8:00 a.m. – 5:00 p.m., EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, **KEN VANDERPUYE** can be reached on (571) 272-3078. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/OJ/

/Kenneth N Vanderpuye/  
Supervisory Patent Examiner, Art Unit 2613